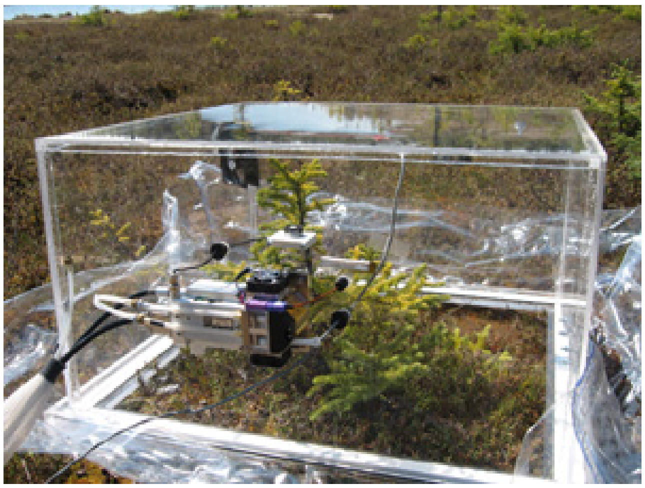
Are the Kenai's drying wetlands sources or sinks of CO_2 to the atmosphere?

by Sue Ives



Graduate student Sue Ives uses an infrared gas analyzer to measure carbon dioxide CO_2 uptake and discharge in wetlands on the Kenai National Wildlife Refuge. Photo Credit: Sue Ives/USFWS

While hiking through a large Kenai Peninsula wetland a few years ago, I noticed an odd thing—the wetland appeared unusually dry. There were large depressions with nothing but cracks in the soil surface, indicating that these depressions typically hold water but were dry at the time of my visit. Much of the vegetation appeared wilted and water-stressed, and try as I might, I couldn't dig a hole deep enough to find the water table in an environment where water is typically near the surface. This trip had me thinking—what will the effects of climate change be on our Kenai Peninsula wetlands?

A bit of reading turned up recent work supporting my observations. Aerial photo comparisons from the 1950s to the 1990s documented a decrease in the amount of open water and grass habitats on the Kenai Peninsula at the same time as an increase in forested habitats. Other work showed that black spruce and dwarf birch shrubs are moving into Kenai Peninsula Sphagnum-sedge wetlands.

Northern peatlands, such as the large wetland complexes that occur throughout the Kenai Peninsula Lowlands, are vast stores of terrestrial carbon and their response to climate change is globally important. As these wetlands dry and woody vegetation moves in, two competing processes are at work: carbon sequestration (storage) through photosynthesis and carbon release through respiration. Depending on which process dominates, drying wetlands can be either a sink or a source of carbon dioxide (CO_2).

Carbon sequestration is the long-term storage of CO_2 removed from the atmosphere. Plants naturally sequester carbon through the process of photosynthesis, when they use the energy provided by sunlight to transform CO_2 to organic compounds and tissue within the plant. As wetlands dry and shrubby vegetation moves in, there are more leaves available to perform photosynthesis and more carbon is sequestered.

Respiration occurs both in plants and in the soil microbial community, releasing CO_2 into the atmosphere. Low soil temperature and high soil water content generally constrain respiration in wetlands. However, as wetlands dry, these constraints are lifted and one would expect to see an increase in ecosystem respiration.

So as wetlands dry, the constraints on both photosynthesis and respiration are lifted and we would expect to see higher levels of photosynthesis (sequestering carbon in the wetland) and higher levels of respiration (releasing carbon from the wetland to the atmosphere).

My work on the Refuge over the past summer has focused on identifying which process dominates: are drying wetlands a source of CO_2 to the atmosphere due to increases in respiration, or are they a sink which sequesters atmospheric CO_2 in newly established woody vegetation?

Aerial view of the wetland where Sue Ives is making CO_2 measurements. The boardwalk allows her to make measurements at exactly the same points throughout the year without trampling the vegetation. Photo Credit: Rick Ernst /USFWS

I have been able to measure the amount of CO_2 captured through photosynthesis as well as the amount released through respiration along a moisture gradient in a Kenai Peninsula wetland. From wettest to driest, the sampled communities are dominated by Sphagnum moss, sedges, dwarf birch, and black spruce. As anticipated, preliminary results indicate that the two drier communities, dwarf birch and black spruce, show higher levels of both photosynthesis and respiration throughout the growing season. What's interesting is that as the growing season progressed photosynthesis far outpaced respiration in the two drier plots, leading to nearly twice as much carbon sequestration in the drier communities than in the wetter communities during the month of July.

At this point, you're probably thinking that this wetland drying trend could actually be good for climate change, if drying wetlands sequester more carbon. Well, there's one more piece to the puzzle to consider. As the snow begins to fall and the leaves drop from the trees, plants are beginning to slow down for the winter and will stop photosynthesizing until next spring. But while photosynthesis will shut down for the winter, soil microbial respiration will continue for many more months. This continued release of CO_2 to the atmosphere through respiration may well negate any differences in CO_2 sequestration in the summer months. I plan to continue monitoring throughout the winter so that I can measure the total annual flux of the wetland. I am quite eager to see how this balance between photosynthesis and respiration plays out!

Sue Ives is a graduate student at Alaska Pacific University working with Professor Roman Dial and Refuge Ecologist Ed Berg. More information on drying Kenai wetlands can be found in past Refuge Notebooks. Previous Refuge Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.